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ABSTRACT

This paper describes on-going research that investigates the effects of an implementation project run in comprehensive schools in Israel. The research also examines teacher's self-esteem, and tries to discover its place in determining the teacher's willingness to adopt innovative practices. Results so far suggest that the implementation project is succeeding in promoting reform in the schools' culture, but the complexity of the content in which teachers operate renders self- esteem nearly insignificant. (Author)

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FACTORS AFFECTING THE IMPLEMENTATION OF REFORMS IN SCHOOL MATHEMATICS

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This paper describes on-going research that investigates the effects of an implementation project run in comprehensive schools in Israel. The research also examines teacher's self-esteem, and tries to discover its place in determining the teacher's willingness to adopt innovative practices. Results so far suggest that the implementation project is succeeding in promoting reforms in the schools' culture, but the complexity of the context in which teachers operate renders self-esteem nearly insignificant.

INTRODUCTION

The aim of the research reported in this paper is to examine the implementation of changes in mathematics teaching practices. It focuses on approaches to the implementation of new teaching-strategies for in-service high-school mathematics teachers, and on their feelings and reactions to this process. This topic has been high on the agenda of PME meetings for some time, and is still under scrutiny. My research also examines teacher's self-esteem, and tries to discover its place (amongst other factors like beliefs, norms, values and context) in determining the teacher's willingness to adopt innovative practices; at the same time, the effects of the reforms implementation on the teacher's self-esteem will be examined.

The research studies an implementation strategy operated by the author in 13 middle and high schools in Israel. The strategy is under constant review in order to improve the implementation methods, find ways to cope with resistance and promote renewal and regeneration of new ways in mathematics education.

THEORETICAL BACKGROUND

Change implementation processes have been widely examined in different contexts, including educational settings. This research looks at the problem from two perspectives: behavioural theories are used to examine beliefs, attitudes, norms and self-esteem; organisational/management theories are used to examine change implementation processes in organisations (schools) and teamwork (as part of the change); educational research literature ties them together.

Whitaker (1998) claims that "a key assumption upon which traditional orthodoxy in education has been built is that teaching in schools is concerned with the transmission of knowledge... that will remain valid throughout our lives." (p.15). This has been especially true for mathematics teaching (Weinzweig, 1999; Norton et al., 2000), and my observations in some 400 classrooms for this research suggest that this is still the case. Therefore, reform cannot occur without a change in the

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mathematics teachers' system of beliefs and conception of the nature of mathematics and theories of teaching and learning. These, in turn, may affect the image and self-esteem of the mathematics teacher, who may undergo a change from the sole authority and source of knowledge, to a co-learner with the students (Clarke, 1997). The teacher needs to become a moderator, stimulating students to question the assertions of their colleagues (Ponte, 2001).

Clarke (1997) identified 12 factors that appear to influence the process of changing teacher roles, amongst them the in-service program. The social context is also a powerful influence. This is a result of the interactions between teachers and pupils, parents, peers and superiors, and their expectations from the teachers (Ernest, 1994). The common myths concerning mathematics and mathematics education also affect the expectations from the teachers, and as a result, affect their performance (Lim and Ernest, 1999). For example: "mathematics is made up of rules and procedures" (Amit and Hillman, 1999, p. 21); "the teacher is the source of knowledge, the pupils – passive receivers" (Weinzweig, 1999, p. 26).

It is therefore apparent that effective professional-development models will need to take these aspects into consideration. The elements that need to be considered when designing such models include:

- the designs should never stop evolving and changing (Loucks-Horsley, 1998). Constant reflection is an essential part of an effective program;
- institutional support is crucial (Ernest, 1994);
- the design should be done through collaborative work (Whitaker, 1998; Valero & Jess, 2000);
- the possibility of a loss of confidence and self-esteem should be taken into consideration (Whitaker, 1998).

Reforms in teaching demand both vision and courage. There are tensions, challenges, doubts, failures, guilt and frustration involved. As Koch (1998) puts it: "Nowhere is reform deeper, more personal, or more threatening than with teachers" (p. 118). And even more so, I find, with mathematics teachers, who are always under public scrutiny. Therefore, mathematics teachers who face a decision on implementation of changes in their practices have to confront the dilemma: how much of their professional persona can they risk? (Sakonidis et al., 2001). Or as House says:

> The personal costs of trying new innovations are often high ... they [innovations] require that one believes that they will ultimately bear fruit and be worth the personal investment. (quoted in Fullan, 2001, p. 36).

Therefore, mathematics teachers' self-esteem seems closely connected to their willingness to attempt implementation of changes in their classroom practices. Many mathematics teachers display high self-esteem: they seem very confident both in their knowledge and in their didactics. Nevertheless, they might be reluctant to adopt new ideas and risk what they consider to be their 'achievements'. On the other hand,

Yackel (1994) gives an example of a teacher who was thought of as an exceptional mathematics teacher and was aware of it; presumably, his self-esteem was high. Nevertheless, Yackel describes his efforts to reform his practice as "remarkable", and attributes this to his deep understanding of mathematics and his mathematical values.

Many psychologists believe that virtually all of human behaviour springs from two motives, the first of which is our desire for self-esteem (the second being our desire for sense pleasure) (Campbell, 1984). There is a wide range of books and articles on self-esteem and ways to measure it; the definitions and measurement of self-esteem are taken mainly from classical psychology (Rosenberg, 1965; Coopersmith, 1967). Blasovitch and Tomaka (1991) suggest an 'integrated' definition of self-esteem:

> Self-esteem is the extent to which one prizes, values, approves or likes oneself (p. 115).

To date, the most popular measurement tool of self-esteem for adults is still the Rosenberg Scale (1967), with the Coopersmith Inventory (1967) not far behind (Blasovitch & Tomaka, 1991).

THE CONTEXT OF THE RESEARCH

Since April 1999 I have been running a project for the implementation of contemporary teaching practices in 13 middle and high schools in Israel. Its aim is to encourage the on-going professional development of the teachers, to help change the teaching practices, to encourage the use of technology and to promote teamwork in mathematics teaching.

On-going support is given to the mathematics teaching staff by assigning each school a 'facilitator' for one day a week for three years. The school's head of mathematical studies (HoD) and the facilitator work together: they lead weekly workshops for the team, train them in up-to-date teaching methods, promote teamwork procedures, lead group learning sessions, and help to experiment with new teaching practices and with the use of technology in the classroom. The facilitators and department heads from the schools taking part in the project attend a monthly meeting in which there is an exchange of ideas, consultations, planning and evaluation of their work and progress (Chissick, 2000).

Regular feedback and reflections are exchanged between the project manager (who is also the researcher) and the facilitators and heads of department, and changes in the project's activities are made accordingly.

METHODS AND ANALYSIS

The research examines two interrelated concepts:

- effective implementation of contemporary mathematics teaching practices (through the above mentioned project);

- the self-esteem of the mathematics teacher, and its effect on his/her willingness to implement changes.

This is qualitative research using non-participant observational techniques (Glaser & Strauss, 1967), as well as questionnaires (both structured and semi-structured). The data accumulated from the project are analysed on a regular basis. As far as self-esteem and its effect on the adoption of reforms by teachers are concerned, the paradigm of grounded theory is adopted (Glaser & Strauss, 1967; Strauss & Corbin, 1998; Dey, 1999).

The analysis is inductive, based on a naturalistic paradigm as in Sanger (1996):

> "The label 'naturalistic' in educational inquiry would signal that the research has been conducted in an educational milieu and seeks to characterise participant activity within programs, projects or other settings" (p.11)

The research questions, the choice of the research tools and the way to use them, as well as the research population, are determined during the process and can be changed during and as a result of analysis. (Gibton, 2001)

In addition to the study of the data accumulated from the schools, case studies will be carried out in two schools; one will be discussed in the next section. The participants are three mathematics teachers (one of them the head of department) in each school. They are observed in their classrooms (three lessons each) and interviewed three times each during the school year. The interviews are semi-structured and concentrate on four themes:

- the teacher's beliefs and attitudes towards mathematics and mathematics teaching;
- the teacher's beliefs and attitude towards the change process;
- the teacher's personal history as a student of mathematics;
- the teacher's self esteem.

Questionnaires about the implementation project have been issued to teachers (at the end of the two previous school years), HoDs and school heads. Microanalysis, as in Strauss & Corbin (1998) has been used to analyse the responses. The codes were entered into a spreadsheet, and sorted twice for analysis: once in the order of Code-School-Document for an overall analysis, and then in the order of School-Code-Document for case studies.

A basic set of codes was built, and changed as deemed necessary while the coding process was going on. The process was flexible and creative: codes were added, discarded or changed along the way.

Non-participant, semi-structured observations were made both at staff meetings and in classrooms. The observation reports included informal, descriptive, narrative accounts (Wragg, 1999) and event-coding tables (Bakeman & Gottman, 1986; Robson, 1993). These were scrutinised for behavioural patterns that may indicate

willingness or resistance to the implementation of reforms, and displays of high or low self-esteem.

In addition, regular weekly semi-structured reports from the project's facilitators, notes on informal conversation, and historical data accumulated in previous years are examined and analysed for indications of the main items mentioned above.

In the event, insufficient data has been collected on the teachers' self-esteem; its effect on the implementation of changes will be need to be studied more thoroughly in the future.

PRELIMINARY FINDINGS AND DISCUSSION - SCHOOL NO. 1

School No.1 is a comprehensive school (grades 7-12, pupils aged 12-18) situated in a development town, surrounded by affluent settlements. The town's population consists of 60% relatively new (residence 3-10 years) immigrants from the former USSR. This has an impact on the teachers (some of whom are new immigrants themselves) and on teaching methods, as the reigning learning paradigm amongst parents is a traditional one.

The implementation project is in its third and last year in the school. The team consists of 12 teachers and two HoDs: P. for grades 7-8, and A. for grades 9-12. They both co-operate willingly with the facilitator. Both are new to the task (first year for P., second year for A.) and are developing as leaders. The facilitator, D., has gained the teachers' trust and confidence by showing significant ability and knowledge, as well as empathy and understanding. This can be seen from the appreciation that the teachers express in the questionnaires and at meetings with the researcher; in addition, the relaxed and open relationship between D. and the teachers is notable.

In the analysis of the questionnaires (administered to the teachers, HoD and facilitator at the ends of the first two years of the project by the external assessor), open coding was used, with line-by-line analysis, as suggested by Strauss & Corbin (1998) and Dey (1999) for the first stages of the analytic process.

Some results can be seen in Table 1 below. In this table some of the codes were gathered into more general categories; for instance: use of technology, use of open-ended tasks, changes in assessment, and overall changes in classroom practices are all under 'changes in classroom practices'.

Further analysis of additional data (summaries of facilitators' meetings, notes from casual talks with D., A. and P.) shows that the facilitator was less convinced of the overall changes in classroom practices and the use of open-ended tasks than the teachers and the HoDs. As far as the use of technology is concerned, both the facilitator and the HoDs thought that some progress was made (although not as much as had been expected) while the teachers were divided on the issue: half of them did not see any progress, while the other half felt that some progress was made. This

might be explained by the fact that each teacher responded from her/his personal viewpoint, whereas D., P. and A. saw the whole picture and responded accordingly. At one of the facilitators-HoDs meetings that are held regularly, A. reported:

> This year I was teaching the role of the parameters in the quadratic function on the shape and place of the graph, when I suddenly realised that this subject could be better taught with the graph-generator on the computer. I 'dared' it, and took the class to the computer lab. It was wonderful. They all understood and could generalise. (CT-371-2009: note on casual talk at a staff meeting, Sep. 2001)

It has to be noted that A. has attended quite a few courses on the use of computers in mathematics teaching in the past, and the benefits of using a computer had been well known to her for some time. It seems that the support and encouragement that D. and her peers gave her, as well as the realisation that she should set an example, gave her the strength to 'take the risk' and brave it. Her report (above) on her experience to the team, and her frankness about her doubts and fears served as a catalysing agent for her peers.

Except for one teacher, everybody felt that they have been going through a process of personal development. It remains to be seen whether this will result in the initiation of further studies or similar processes in the future.

As can be seen in Table 1, teamwork culture, which is one of the main aims of the project as an instrument for progress and reforms implementation, seems to be having an impact on the teachers. Most teachers reported active participation and peer-support.

Category	Dimension / properties	Score
Overall reform implementation	significant	6
	slight	6
	none	1
	negative	1
Changes in classroom practices	extensive	50
	few	19
	none	12
Head of Department status	strengthened a lot	3
	strengthened a little	2
	no change	1
Teacher's development	occurred	15
	did not occur	1
Teamwork culture	changed significantly for the better	63
	very little change	15
	no change	3

Table 1: Results of questionnaires' analysis - School No. 1

The effects of the implementation project on teaching practices and on teamwork can already be seen. The atmosphere in the department has changed: teachers consult each other, work in groups on subjects of common interest, produce open-ended assignments and worksheets and discuss assessment policies.

DISCUSSION

Analysis of the results from all the schools taking part in the research so far shows a significant change in teamwork culture in all the schools; some changes of classroom practices (excluding the use of technology) which includes the use of open-ended tasks and more pupil-centered teaching; and a general feeling amongst the teachers that they are undergoing a process of professional development. School No. 1 seems to represent the general results fairly accurately. These results may imply that the implementation project is successful in promoting the adoption of reform practices. Nevertheless, it remains to be seen if the effects of the project remain, and if the teams can carry on the momentum on their own.

Not enough data has yet been collected about the teachers' self-esteem; therefore, it is too early to come to conclusions about its effect on reform implementation. Although it is widely believed that self-esteem is a major factor that affects human behaviour (Campbell, 1984), it may be that the complexity of the context in which teachers operate renders this factor nearly ineffective. From close acquaintance with some of the teachers, it seems that there is no immediate connection between self-esteem and readiness for change; self-esteem may turn out to be just one of the many varied factors (for example: external exams, peer support, content knowledge, school environment, time limit and more) that affect the willingness of mathematics teachers to implement new teaching practices. It is expected that in-depth interviews, and the use of the self-esteem measurement scales (mentioned above) will give more insight on the counter-effects of self-esteem and reform implementation.

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